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(54) Title: CODED ITEMS FOR LABELLING OBJECTS

(57) Abstract

A microparticle which is invisible to the naked eye and is marked with a machine readable code. A tagging compound comprising a powder, fluid or gas when mixed with one or more set or sets of microparticles of which each has a predetermined shape representative of a unique code selected from a multiplicity of such codes, such that the presence of the microparticles is undetectable to the naked eye.

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Coded Items for Labelling Objects

This invention relates to coded items for labelling objects such as vehicles, credit cards and jewellery, and is particularly useful for the invisible labelling of such objects with security marks to enable the objects to be identified or their origin to be identified.

Many methods are employed to protect merchantable items from theft or forgery. Car chassis and engines have serial numbers, credit cards have holographic icons, etc. Ultimately, all these devices can be defeated by either removal or replication. Ideally, an item would be marked with a security device which was impossible to remove or replicate, or where the effort required to remove or replicate it exceeded the value of the item itself.

The invention provides a microparticle which is invisible to the naked eye and is marked with a machine readable code.

The invention also provides a tagging compound comprising a powder, fluid or gas when mixed with one or more set or sets of microparticles of which each has a predetermined shape representative of a unique code selected from a multiplicity of such codes, such that the presence of the microparticles is undetectable to the naked eye.

The invention also provides a method of marking an object invisibly with a machine-readable code, comprising applying to the object a set of microparticles of the above type.

By applying such microparticles to an item, the item

can be marked extensively or even covered without detracting from its aesthetic or practical purpose.

Preferably, the microparticle is in the form of a wafer whose thickness is from 0.1μ to 5μ and whose width and length are both in the range of 0.5μ to 50μ ; preferably, the microparticle is of silicon or silicon dioxide. Such particles can be made by micromachining.

Silicon micromachining is a process developed from the electronics industry. The processes and techniques used in silicon micromachining are based largely upon the highly refined fabrication technology used in semiconductor manufacture - with the objective in micromachining being the creation of microscopic physical or mechanical structures on silicon wafer substrates as opposed to electronic circuitry.

It has been shown in The Production of Precision Silicon Micromachined Non-spherical Particles for Aerosol Studies - Kaye, P.H., Micheli, F., Tracey, M., Hirst, E., and Gundlach, A.M. Journal of Aerosol Science. Vol. 23, Supplement 1, pp 201-204, 1992, that extremely uniform microscopic particles of silicon or silicon dioxide (glass) or a metal such as aluminium, silver, or gold, can be made using the process of silicon micromachining. These particles may be of dimensions from about 0.5μ to 50μm or more across, and from about 0.1 to 5μm thick. (A printed period mark by comparison is typically 500μm across). The shapes of the particles are designed using a computer-aided-design (CAD) programme and may be of virtually any desired form within the limitations mentioned

above. A single silicon wafer of normally 7.5cm (3 inch) or 20cm (8 inch) diameter is used as the substrate on to which the desired particle shapes are projected using an optical mask or directly drawn using so-called e-beam writing. The particles are subsequently formed on the wafer using the deposition and etching processes of silicon micromachining. Typically 200 million particles can be formed on a 7.5cm (3 inch) wafer, each of the particles accurately defined in size and shape. Normally all the particles on one wafer are designed to be of identical size and shape so that when the particles are freed from the wafer substrate (using a further etching process) one is left with a suspension containing a single particle type.

Because the particles can be made to a uniform and predetermined shape they can be used as identifying markers. Thus their shape alone can be the unique identification. However, in the preferred example, apart from the shape of each particle being defined, each particle is marked with pits, holes, notches, or other marks so that it is characterised by a unique mark. The marks may form a binary code or some other encrypted coding which only the designer of the particle may have access to. Each particle could then carry a code of typically several hundred binary 'bits' of information.

In order unambiguously to optically image a unique binary number etched in the form of pits, holes, etc. forming a pattern on the microparticle, it is necessary for each constituent mark which represents a binary bit of the

number to satisfy Abbe's Condition for the microscopic imaging system in question. With white light illumination and a microscope objective of Numerical Aperture 0.5 the bit spacing should typically exceed approximately 1.2 micrometres. Such an objective, in reflector form, can display a working distance of approximately 16mm and a usable depth of field of approximately 5 micrometres. Such a microscope would be suitable for the analysis of objects such as credit cards or identity cards. Microscopic analysis of larger objects would either require a sample to be removed for analysis (for instance a paint sample from an automobile) or would require the design of a microscope mounting specific to that application (for instance a magnetic mounting or precisely defined objective to base distance such that when held on a plane it is in focus).

An alternative to microscopic analysis would be offered by the employment of a scanning system (analogous to a very high resolution 'bar code reader') employing a laser beam and appropriate optics to produce a narrow, collimated beam in conjunction with electronics to control the beam and interpret the interaction between the beam and the object under scrutiny. Such a system could offer a focused working distance range sufficient to allow hand-held scrutinisation instruments to be employed.

Additionally the particles should be patterned in such a manner as to ensure that ambiguous pattern interpretation cannot occur in the case of 90, 180 or 270 degree rotation from the intended viewing orientation; ambiguous

interpretation due to imaging the microparticle's incorrect face should also be precluded. The addition of unique corner patterns could be employed to achieve this.

A particle meeting this design constraint, when imaged by a microscope, will form an image on the imaging element of a video camera. This image, in electronic form, can be digitised and processed by a computer using image processing software. Numerous conventional algorithms can be employed by this software to uniquely identify the morphology of the imaged microparticle. Their operation would typically involve:

(i) Delineating the object image from its background. This operation could be performed by a general purpose commercial image processing package such as Optimas or Visilog.

(ii) Interpreting the morphology of the object in order to ascertain the pattern of marks and hence the unique binary number. This operation would probably employ custom-written software to interpret the data produced by (i).

A suspension of particles, all having identical code markings, may then be used to uniquely identify an object and thus act as a security tag. Examination of the particles on the object can be achieved for example with an optical reader similar to (though of higher resolution) than a bar-code reader found in supermarkets, and the code contained on the particles then identifies the rightful ownership of the object.

For example, an item of jewellery such as a gold necklace could be coated in part or whole with a transparent

lacquer containing a suspension of particles. The lacquer would dry to become invisible, and the particles contained, though invisible to the human eye, could nevertheless be viewed using a suitable magnifying device so as to reveal the hidden identity code. To avoid the possibility of the lacquer being removed by a solvent (thus removing the particles as well), the particles could be stamped into the jewellery at the time of hallmarking, thus becoming essentially part of the item itself, resilient to removal without totally removing the hallmarks (which would normally significantly reduce the value of the item).

Another example could be the unique marking of credit cards and similar 'plastic' devices for electronic financial transactions, or paper currency or security bonds etc. The cards could be marked at some point(s) with an 'ink' containing the particles. Again the particles would each carry a copy of a unique coding tag which could be traceable to the rightful owner of the card. An imaging system, again like a bar-code reader, could be used to 'read' the data on the particles and ascertain the authority of ownership. Removal of the ink and particles would render the card invalid.

Another example would be to apply the particles (all having the same code) with the top layer of paint or varnish onto a motor car. The particles, invisible to the naked eye, would not detract from the appearance of the vehicle. By coating the whole vehicle, inner facing panels included, with this coded paint, a potential thief would have to

remove all the paint from the vehicle to remove all the particles in order to prevent its true identification becoming known. Such a process, and subsequent repainting, would involve so much labour as to render the original theft non-profitable. Typically, one particle per square millimetre of surface area would be required to coat the vehicle. This may amount to 20 million particles per vehicle, i.e. corresponding to approximately one-tenth of a 7.5cm (3 inch) wafer's worth.

A further example would be to incorporate the particles in so-called security smoke devices. These devices are found for example in hole-in-the-wall cash machines and armoured vehicles. They release automatically a smoke dye to cover the currency and possibly the thief when disturbed. The particles would also cover the currency and thief and, because they would carry a unique code, would provide a means of linking a specific item of currency or person to the specific incident.

Any item could in theory be marked in this way to provide identifying security marks. The particles have many advantages including that (i) they can be made identically and in huge numbers by the process of micromachining - they can be made if desired in silicon dioxide, i.e. glass (coloured if required) and as such be impervious to most acids etc., (ii) their production, e.g. through the process of micromachining, is non-trivial and requires highly specialist equipment and skills, thus unauthorised replication of the particles would be very difficult to

achieve, and (iii) they are essentially invisible to the naked eye.

If more information is required to identify an article, a mixture of two or more sets of differently-coded particles could be applied, at the cost of longer read-time by the optical scanning device.

Although in many examples it is appropriate to coat outer surfaces of the objects with the identifying particles, it is envisaged that liquids and other fluid materials such as drinks, fuels and perfumes could be marked by mixing with the microparticles. Even solid objects could be impregnated internally with the microparticles, or the microparticles could be mixed with fluid materials during the manufacture of the solid objects, e.g. in a mould.

CLAIMS

1. A microparticle which is invisible to the naked eye characterised in that it is marked with a machine readable code.

2. A microparticle according to Claim 1, in the form of a wafer whose thickness is from 0.1μ to 5μ and whose width and length are both in the range of 0.5μ to 50μ.

3. A microparticle according to Claim 1, comprising silicon, silicon dioxide, or a metal.

4. A microparticle according to Claim 3, comprising aluminium, silver or gold.

5. A microparticle according to Claim 1, whose readable code is readable by an optical device.

6. A microparticle according to Claim 1, in which the code is representative of data comprising a multiplicity of bits.

7. A set of a multitude of substantially identically-encoded microparticles each according to Claim 1.

8. A set of microparticles according to Claim 6, all being of substantially the same size and shape.

9. A tagging compound comprising a powder, fluid or gas when mixed with one or more set or sets of microparticles according to Claim 7, such that the presence of the microparticles is undetectable to the naked eye.

10. A tagging compound comprising a powder, fluid or gas characterised in that the powder, fluid or gas is mixed with one or more set or sets of microparticles of which each has a predetermined shape representative of a unique code selected from a multiplicity of such codes, such that the

presence of the microparticles is undetectable to the naked eye.

11. A tagging compound according to Claim 9, comprising a paint or ink or fluid dye.

12. A tagging compound according to Claim 9, comprising a smoke dye.

13. A container for tagging an object or objects with a readable code, containing a tagging compound according to Claim 9, and having means for dispensing the tagging compound from the container.

14. A method of marking an object invisibly with a machine-readable code, characterised by applying to the object a set of microparticles according to Claim 7.

15. A method of marking a vehicle invisibly with a machine-readable code, characterised by applying to the vehicle a set of a multitude of substantially identically-encoded microparticles each invisible to the naked eye and marked with a machine readable code, in which the set of microparticles is part of a tagging compound according to Claim 11 and is applied as a coating to the vehicle surface.

16. A method of marking an inherently valuable item such as jewellery invisibly with a machine-readable code, characterised by applying to the inherently valuable item such as jewellery a set of a multitude of substantially identically- encoded microparticles each invisible to the naked eye and marked with a machine readable code, in which the set of microparticles is part of a tagging compound according to Claim 11 and is applied as a transparent

hardenable lacquer to the surface of the item.

17. A method of marking an inherently valuable item such as a plastics card, such as a credit or charge card invisibly with a machine-readable code, characterised by applying to the inherently valuable item such as a plastics card, such as a credit or charge card a set of a multitude of substantially identically-encoded microparticles each invisible to the naked eye and marked with a machine readable code, in which the set of microparticles is part of a tagging compound according to Claim 11 and is applied selectively as an ink or lacquer.

18. A security device for cash machines or other public access dispensing devices, fitted with a container according to Claim 13 in the form of an automatically actuable smoke canister filled with the tagging compound which comprises a smoke dye.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 95/00756

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G09F3/00 G06K19/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G09F G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 243 734 (G. DILLON) 6 January 1981 see the whole document ---	1-18
X	US,A,4 329 393 (J. LAPERRE) 11 May 1982 see the whole document ---	1-18
X	US,A,4 390 452 (E. STEVENS) 28 June 1983 see the whole document ---	1-18
X	GB,A,1 568 699 (E. STEVENS) 4 June 1980 see the whole document ---	1-3,5-18
X	US,A,4 053 433 (P. LEE) 11 October 1977 see the whole document ---	1-3,5-18
P,X	EP,A,0 629 989 (C. LOVING) 21 December 1994 see the whole document -----	1-3,5-18

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☒ Patent family members are listed in annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4243734	06-01-81	NONE		
US-A-4329393	11-05-82	NONE		
US-A-4390452	28-06-83	NONE		
GB-A-1568699	04-06-80	CA-A-	1056653	19-06-79
		DE-A-	2651528	12-05-77
		FR-A,B	2330537	03-06-77
		JP-A-	52068278	06-06-77
US-A-4053433	11-10-77	CA-A-	1064244	16-10-79
		DE-A-	2607014	07-10-76
		FR-A,B	2301888	17-09-76
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		JP-C-	1236765	31-10-84
		JP-A-	51107800	24-09-76
		JP-B-	59012137	21-03-84
EP-A-0629989	21-12-94	NONE		